

REMARKS

This communication is a full and timely response to the non-final Office Action dated July 28, 2003. By this communication, Applicants have amended the specification to correct typographical errors. No new matter has been added. Claims 1-3 are pending, where claim 1 is independent.

Objection to the Specification

The disclosure was objected to for allegedly containing numerous spelling and grammatical errors. Applicants have attached both annotated and clean versions of a Substitute Specification that addresses and remedies the issues raised by the Office Action. Applicants submit further, that the amended specification contains no new matter. Accordingly, Applicants respectfully request that the objection to the disclosure be withdrawn.

Rejection Under 35 U.S.C. §102

Claims 1-3 were rejected under 35 U.S.C. §102(b) as anticipated by *Tabuchi*, U.S. Patent No. 4,440,841. Applicants respectfully traverse this rejection.

Independent claim 1 recites a photomask provided with shielding patterns made of shielding metallic thin film on a transparent substrate, wherein the photomask further comprises translucent patterns mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride or mixture thereof.

The object of the present invention is to provide a photomask capable of making two different species of patterning in one photomask to reduce the steps of photolithography. In other words, the mask patterns to be printed on a silicon wafer are two species. These two species are related to the shielding patterns and the translucent patterns, respectively, which are also different from one another. Moreover, the thin film layers of the photomask of the present invention are the shielding metallic thin film/translucent metallic thin film, as recited in claim 1, and the shielding metallic thin film/intermediate layer/translucent metallic thin film, as recited in claim 2. The thin film layers of the shielding metallic thin film, intermediate layer, and translucent metallic thin film are subjected to patterning to form the mask patterns. The two species patterning of the photomask recited in claim 1 enables a

reduction in the steps of photolithography, thereby enabling the low cost, high throughput patterning to be performed.

Tabuchi is directed to providing a photomask having sufficient electroconductivity and chemical resistance to prevent silicon wafer elements from being destroyed by electrostatic charges at the time of pattern printing and occurrence of pattern defects of the photomask and also being capable of dimensional measurement and evaluation of registration by an electron-beam system. Moreover, the photomask is provided with an electroconductive film on a transparent substrate, a protective film for protecting the electroconductive film and a shielding pattern on the protective film. In other words, the electroconductive film is provided on the entire surface of the transparent substrate for giving electroconductivity, and because only the electroconductive film is low in chemically resistant property, the protective film for protecting the electroconductive film is formed on the electroconductive film, and a mask pattern layer is provided on the protective film, and hence there is only one species of mask patterns. Furthermore, *Tabuchi* discloses that the thin film layer of the photomask is the shielding metallic film/protective film/electroconductive film. Still further, the protective film and the electroconductive film are provided on the entire surface of the transparent substrate but neither discloses, teaches, or suggests that protective film and the electroconductive film are subject to patterning.

As noted above, claim 1 recites, among other things, the photomask further comprises translucent patterns mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride, or mixture thereof. *Tabuchi* fails to disclose, teach, or suggest at least this claim element. Moreover, *Tabuchi* fails to disclose, teach, or suggest at least means for solving the same problem as the invention recited in claim 1. Moreover, the construction and effect of the apparatus and method disclosed by *Tabuchi* is not analogous to the invention of claim 1. To properly anticipate a claim, the document must disclose, explicitly or implicitly, each and every feature recited in the claim. See Verdegall Bros. v. Union Oil Co. of Calif., 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). For at least these reasons, Applicants respectfully request that the rejection of claim 1 under 35 U.S.C. §102 be withdrawn, and claim 1 be allowed.

Claim 2 depends from claim 1, and additionally recites an intermediate layer is provided between translucent pattern layer and shielding pattern layer. As noted above, *Tabuchi* discloses a thin film layer of the photomask includes a shielding metallic thin film, a

protective film, and an electroconductive film. *Tabuchi*, however, fails to disclose, teach, or suggest at least an intermediate layer as recited in claim 2. Accordingly, because *Tabuchi* fails to disclose, teach, or suggest every feature recited in claim 2, Applicants submit that claim 2 is not anticipated. Accordingly, Applicants respectfully request that the rejection of claim 2 under §102 be withdrawn, and this claim be allowed.

Claim 3 depends from claim 2, and additionally recites the intermediate layer is made of silicon oxide. As noted above, *Tabuchi* discloses a thin film layer a protective film made of silicon oxide provided on the entire surface of the transparent substrate. Applicants submit, however, that the silicon oxide layer disclosed by *Tabuchi* is different from the silicon oxide layer used as the intermediate layer, as recited in claim 3. Therefore, because *Tabuchi* fails to disclose teach or suggest at least an intermediate layer as recited in claim 3, claim 3 is not anticipated. Accordingly, Applicants respectfully request that the rejection of claim 3 be withdrawn, and this claim be allowed

Conclusion

Based on at least the foregoing amendments and remarks, Applicants submit that claims 1-3 are allowable, and this application is in condition for allowance. Accordingly, Applicants request favorable reexamination and reconsideration of the application. In the event the Examiner has any comments or suggestions for placing the application in even better form, Applicants request that the Examiner contact the undersigned attorney at the number listed below.

Dated: October 28, 2003

Respectfully submitted,

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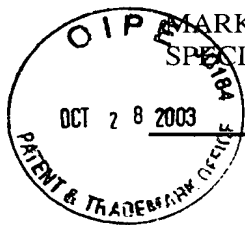
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PHOTOMASK

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BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a photomask.

2. Related Art:

In ~~the~~ a process for producing a semiconductor device, a display and others, ~~it is carried out to transfer~~ patterns written on a photomask are transferred to a wafer, a substrate of display panel, and others. Namely, the steps for transferring patterns of a photomask to a wafer, a substrate of display panel, and others, are carried out beginning from an application of a photo resist ~~on~~ onto a wafer, a base of display panel, and others, carrying out a demagnification projection by means of a stepper, developing the photo resist to form a mask, and etching ~~of~~ a liner or under a film through a photo resist as a mask and ~~a~~ thereafter removing unnecessary areas of the photo resist.

It is said that large-scaled amorphous silicon TFT and LCD ~~for monitor~~ devices used as the display of a notebook personal computer and a desktop personal computer, are produced through five to six of steps of patterning made by photo etching ~~for~~ a substrate of the TFT. Therefore, it is required that these steps of photolithography are simplified to reduce the cost of production.

However, there is a limit in the simplification of steps of photolithography in a conventional system for transferring patterns to a wafer and others, by transmitting or shielding projected light through ~~existence or not of~~ shielding patterns on a photomask, when the shielding patterns are present or not.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a photomask ~~which~~
that enables the simplification of steps of photolithography.

Inventors made a study in order to attain the above-mentioned object. As a result, inventors found that projecting ~~amounts a number of rays depending on the area~~ to a wafer based on the area becomes possible ~~by through a conventional photomask having shielding pattern films made of shielding metallic thin film formed on a transparent substrate, wherein the~~ The photomask is further provided with translucent patterns made of translucent metallic thin film including mainly ~~including tantalum of~~ The tantalum is made from materials selected from tantalum silicide, tantalum oxide, tantalum nitride or a mixture thereof, ~~that, the~~ The steps of projection and development made using the photomask ~~and development~~ bring about a difference in solubility between a part of resist corresponding to shielding patterns and a part of a resist corresponding to translucent patterns by which a resist pattern comprised of a ~~part portion of~~ patterns having the thickness of resist patterns formed ordinarily and a ~~part portion of~~ thinner patterns can be formed ~~and that thereby, it~~ It is made then possible to make two species of patterning in one photomask so that the reduction of the number of masks ~~are made possible~~ is realized. The inventors made the present invention based on the basis of the above-mentioned knowledge.

Namely, the present invention, as mentioned in claim 1, is a photomask provided with shielding patterns made of shielding metallic thin film on a transparent substrate, wherein the photomask further comprises translucent patterns mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride or mixture thereof.

Layers formed on an insulating substrate, according to the present invention, can be formed into patterns through the steps of overlaying the layers

with a resist pattern comprised of a part of patterns having the thickness of resist pattern formed ordinarily and a part of patterns made of thin film, etching the layers through the resist pattern so that the layers are formed into patterns, thereafter removing the part of patterns made of thin film by O₂ ashing and the like so that a part of the layer covered with the part of patterns made of thin film is exposed, and further etching a part of the exposed layer by which the number of steps of photolithography can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic sectional view of a photomask of the present invention.

Fig. 2 is a sectional view of resist pattern formed using a photomask of the present invention.

Fig. 3 is a sectional view for illustrating the steps of production of a photomask of the present invention.

Fig. 4 is a sectional view for illustrating the steps of production of a photomask of the present invention made following the steps of production of a photomask shown in Fig. 3.

Fig. 5 is a sectional view showing the steps of patterning made using a photomask of the present invention.

Fig. 6 is a sectional view showing the steps of patterning made using a photomask following the steps of patterning shown in Fig. 5.

PREFERRED EMBODIMENT OF THE INVENTION

Fig. 1 shows conceptually the structure of photomask of the present invention. A photomask of the present invention comprises a transparent substrate 1a and shielding patterns 2 made of shielding metallic thin film wherein the

photomask further comprises translucent patterns 3 made of translucent metallic thin film mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride or mixture thereof.

In a photomask of the present invention, optically transparent materials such as soda-lime glass, quartz glass, and sapphire can be used as the transparent substrate.

Further, materials such as Cr, Cr₂O₃, and Si can be used as a shielding metallic thin film for forming shielding patterns.

Intermediate layer such as SiO₂ can be provided between a shielding metallic thin film and a translucent metallic thin film. The intermediate layer prevents translucent metallic thin film from being damaged by over-etching when etching the shielding metallic thin film.

In the present invention, the reason that translucent patterns are made of materials mainly including tantalum is ~~based on that~~ because materials mainly including tantalum are the most suitable materials that not only make easy the adjustment of optical amounts with the adjustment of thickness, but also have excellent workability and durability.

The translucence of translucent patterns can be adjusted according to the thickness of the translucent metallic thin film. Further, the adjustment of the translucence of translucent patterns can be possible in the following method: a plurality of openings having size under a resolution of limit of an aligner are formed in a translucent metallic thin film ~~in such an extent~~ that writing is not ~~made possible~~ by light passing through the openings so that amounts of applied rays to the whole of translucent pattern is lacking for exposure.

Fig. 2 shows schematically a resist pattern made using a photomask of the present invention. Exposure and development made using a photomask of the present invention produces a difference in solubility of exposed material against

developing a solution between a part of a resist corresponding to shielding patterns 2 and a part of the resist corresponding to the translucent patterns 3. Accordingly, a resist pattern comprised of a part 5 of patterns having the thickness of the resist pattern formed ordinarily and a part 6 of patterns made of thin film is formed. (In Fig. 2, a photomask is shown with enlarging crosswise a photomask against a photomask shown in Fig. 1 to be easy to be seen.)

Then, referring to Figs. 3 and 4, a method for producing a photomask of the present invention is explained. First, a blank is provided in which the translucent metallic thin film 11 mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride, or a mixture thereof and the shielding metallic thin film 12 made of materials such as Cr and further the resist 13 is applied on the shielding metallic thin film 12 as shown Fig. 3(a).

Then, a resist pattern 14 for forming shielding patterns is formed by carrying out a first writing and development as shown in Fig. 3(b).

Then, the shielding metallic thin film 12 is etched by wet etching or dry etching so that the shielding patterns 2 is formed as shown in Fig. 3 (c).

Then, the resist patterns 14 are removed as shown in Fig. 4 (a). Thereafter, then resist 13 is again applied on the translucent metallic thin film 11 and the shielding patterns 2 as shown in Fig. 4(b). Then, a second writing and development are carried out so that resist patterns 15 for forming translucent patterns are formed as shown in Fig. 4 (c).

Then, the translucent metallic thin film 11 is etched by dry etching or wet etching so that the translucent patterns 3 are formed as shown in Fig. 4(d).

Finally, a photomask can be obtained by removing the resist 13 as shown in Fig.1.

Then, referring to Figs. 5 and 6, an example of application of a photomask of the present invention is explained.

First, as shown in Fig. 5 (a), a gate line 21 is formed on an insulating substrate (not shown) thereby laminating metallic materials such as Al/Mo in the same manner as a conventional method, ~~as shown in Fig. 5(a).~~ Then, SiNx film 22 and a \cdot Si film (amorphous silicon film) 23, N^+ a \cdot Si film (N^+ amorphous silicon film)24 are laminated on ~~a~~ an insulating substrate provided with the gate line 21. Further, a film 25 of materials such as a Cr/Mo and Ti/M is laminated on the N^+ a \cdot Si film 24. Thereafter, a resist pattern 26 covering a source electrode, a drain electrode and a channel portion is formed using a photomask of the present invention.

Then, a part of the source electrode, drain electrode and pixel electrode and others uncovered by the resist pattern 26 is removed by etching (refer to Fig. 5(b)).

Then, a part of the resist pattern 26 thinly formed covering the channel portion is removed by O_2 ashing (refer to Fig. 5(c)).

Then, a part of film 25 ~~of~~ made of materials such as ~~a~~ Cr/Mo₂ and Ti/M₂ and a N^+ a \cdot Si film (N^+ amorphous silicon film)24 corresponding to the channel portion is removed by etching and, ~~finally,~~ the resist pattern 26 is removed (refer to Figs. 6(a) ~ (c)).

Thereafter, a film of passivation dielectrics is formed so that TFT is obtained.

As mentioned hereinabove, according to the present invention, two species of patterning can be carried out in one mask.

Then, an example of a photomask of the present invention is given.
(Example)

First, a glass polished on double sides with a size of 6 inch \times 6 inch and thickness of 0.12 inch is provided. After washing of the glass, a tantalum layer with thickness of 200 angstrom and transmittance against rays of wavelength 436

nm more than 20% is formed by carrying out a sputtering ~~as~~ process under the following conditions.

Sputtering conditions:

(Magnetron sputter)

DC magnetron

A use of metallic tantalum target

Argon gas 50 sccm

Pressure: 0.3 Pa

Current: 3 ampere

Then, a layer of SiO₂ with a thickness of 500 angstrom is formed by carrying out a sputtering process under the following conditions.

Sputtering conditions:

(Magnetron sputter)

RF magnetron

A use of SiO₂ target

Argon gas 50 sccm

Pressure: 0.1 Pa

Electric power: 1 kilowatt

Then, double layers of chromium are formed on the layer of SiO₂ carrying out a sputtering process under the following conditions.

Sputtering Conditions:

(Magnetron sputter)

A use of metallic chromium target

First layer

Argon gas 50 sccm

Pressure: 0.3 Pa

Current: 0.3 ampere

Thickness: 800 angstrom

Second layer

Argon 30 sccm + Oxygen 70 sccm

Pressure: 0.3 Pa

Current: 2 ampere

Thickness: 200 angstrom

Further, a resist is applied on the double layers of chromium by a conventional spin coating method, thereafter writing and developing are carried out by an electron beam lithography method to form a resist pattern for forming shielding patterns.

Then, the chromium layer and the SiO₂ layer are etched through the resist pattern under the following conditions to form shielding patterns.

Etching conditions:

A use of dry etching equipment (VLR manufactured by UNAXIS Inc.) (Etching of chromium)

Etching gas	Cl ₂ + O ₂ gas (the ratio of 2:3)
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Pressure	10 mTorr
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ICP power	500 W
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(Power for generating a high-density plasma)

Bias power	25 W
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(Power for extracting plasma to the side of the substrate)

Time required for etching	360 seconds
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(Etching of SiO₂ layer)

Etching gas	CF ₄ gas
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Pressure	100 mTorr
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ICP power	950 W
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(Power for generating a high-density plasma)

Bias power 50 W
(Power for extracting plasma to the side of substrate)

Time required for etching 30 seconds

Then, after the resist is removed, rinsing was carried out. Thereafter, the resist is applied on the formed shielding patterns and alignment writing and development are carried out by a conventional electron beam lithography, so that a resist pattern for forming ~~a~~ the translucent patterns is formed. Thereafter, dry etching is carried out under the following conditions to form translucent patterns.

Etching conditions:

A use of dry etching equipment (VLR manufactured by UNAXIS Inc.)

Etching gas Cl₂ gas
Pressure 100 mTorr
ICP power 500 W
(Power for generating a high-density plasma)
Bias power 25 W
(Power for extracting plasma to the side of substrate)
Time required for etching 30 seconds

Thereafter, the resist was removed and ~~rising~~ rinsing is carried out, so that a photomask of the present invention is obtained.

As mentioned hereinabove, a photomask of the present invention is a photomask provided with shielding patterns made of shielding metallic thin film on a transparent substrate, wherein the photomask further comprises translucent patterns mainly including tantalum of materials selected from tantalum silicide, tantalum oxide, tantalum nitride or mixture thereof. Therefore, the photomask of the present invention enables the formation of a resist pattern comprised of a ~~part~~ portion of patterns having the thickness of resist patterns formed ordinarily ~~and a part of thin patterns~~. Accordingly, the photomask of the present invention ~~makes~~

~~possible to make~~ allows two species of patterning to be made in one mask, so that the steps of photolithography can be reduced. Accordingly, work of patterning made by means of photomask can be carried out with low cost and high throughput.